Measuring the welfare gains from trade: the case of China's entry into the WTO

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UFR 02 SCIENCES ECONOMIQUES

MASTER 2 ECONOMIE THÉORIQUE ET EMPIRIQUE

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June 2013

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1 Introduction

Measuring the welfare gains from trade is a question which has preoccupied trade economists for centuries. Ricardo (1817) was one of the first to formally address this topic using a simple theoretical model. In his model, trade is triggered by the existence of differences in productivities across countries. Thanks to the sharing of production, countries can specialize in the sectors in which they are relatively more productive, hence benefit from lower price. The gains from trade come from reallocation of activities between sectors. Since Ricardo, the theoretical paradigm in international trade has evolved try including new features of the international trade. Monopolistic competition models (such as Krugman 1980) are motivated by the existence of intra-industry trade, while heterogeneous firms models (as Melitz 2003) allow firms to be different in terms of productivity. Unsurprisingly, considering these dimensions highlighted new sources of gains from trade. In monopolistic competition models, the consumers gain from trade from an increase of the range of varieties available in the country. In heterogeneous firms models, the gains come from reallocation of activities between firms: only the most productive ones will remain on the market after liberalization. Given this theoretical diversity, measuring empirically the welfare gains from trade is challenging: we must define which model should we consider to derive an aggregate measure of the gains from trade and find how reconcile all these sources of gains.

In their paper, Arkolakis et al. (2012) shows that in the three standard trade models considered above, welfare gains from trade can be summarized by a unifying measure: despite, structurally different underlying mechanisms, a given shock to the international trade has identical effects. This unifying measure facilitates the empirical analysis of such shocks. Implement this formula, the integration of China into the World Trade Organization (WTO) in the 11th of December 2001 seems to be a well-suited event. In order to enter the WTO, China had to relax over 7,000 tariffs, quotas and other trade barriers. An extensive Computable General Equilibrium (CGE) literature, lead by the Global Trade Analysis Project, studied this episode of liberalization ex-ante. The conclusions of their research was quite optimistic: the analyses concluded that a greater openness would trigger huge gains for China as a whole. The aim of our study is to assess the actual impact of such policy on Chinese welfare[1] a decade after the liberalization. To do so, we use the methodology introduced by Arkolakis et al. (2012). We find that the gains over the period are substantial. Due to the liberalization, the aggregate welfare increased by about half a percent. In line with theory, the sectors in which China benefited the most are the ones in which it had a comparative disadvantage before the liberalization.

[1] Our goal is not to study the impact on the distribution of welfare even though we believe it is very interesting.

The organization of our paper is as follows. Section 2 aims at motivating our analysis by presenting the literature that studied the welfare gains from trade and introducing the specificity of China's entry into the WTO. Section 3 describes the methodology we follow to assess the welfare gains from Chinese liberalization. Section 4 focuses on the data required. Section 5 develops the results at the aggregate level and at the sectoral level. Section 6 concludes.

2 Motivation

Measuring the effect of trade policies is a central issue in empirical trade literature. Considering the difficulty to reconcile all the sources from gains from trade, several papers tried to measure the precise impact of one given channel (in particular Feenstra 1994, Broda and Weinstein 2006). Our research question relates to another trend of the research which aims to examine the impact of specific events of trade liberalization. We want to know what the overall impacts of a country trade liberalization are on its welfare and if the welfare of its trade partners is affected. There exist two different ways to approach the question: either by conducting an ex-ante analysis, which quantifies the potential effect of a policy, or by doing an ex-post assessment of the actual effects of a given liberalization. The second type of analysis is useful as it assesses the actual impact, and verifies the validity of the method used for simulation of the ex-ante analyses. The existing empirical literature examined several liberalization episodes, among those NAFTA and MERCOSUR. The extensive literature studying NAFTA is composed of both ex-ante and ex-post analyses. The ex-ante analyses date back to the 1990s, before the NAFTA agreement was signed, and they rely mostly on simulation methods such as CGE to estimate the potential effect of such liberalization on the United-States, Canada and Mexico. A decade later, several papers studied the actual effect of NAFTA on the three countries of interest and their trade partners, among others Kehoe (2003), Trefler (2004) and Romalis (2007).

The entry of China into the WTO is a recent event of trade liberalization; therefore, the ex-post literature is not as developed as it is on NAFTA. It has been a long and difficult process of liberalization for China as it had to apply the following basic principles the GATT and the WTO in order to be consider a WTO member: (i) non discrimination, (ii) market opening, (iii) transparency and predictability, (iv) undistorted trade, and (v) preferential treatment for developing countries. The first and second principle are the key for the trade liberalization process. The first implies that China treats equally the competing suppliers and does not discriminate between domestically produced and imported goods or services in its internal market. The second one ensures an abolishment of non-tariff barriers, a reduction of tariffs, and an

opening of the service sector. With China's entry into the WTO, the importing countries also committed to abolish the quotas on textiles and clothing imposed by the Multi Fibre Arrangement (MFA) by 2005. The tariff reductions in China were considerable but gradual as shown in the Table 1. In the manufacturing sectors, most of the tariff cuts occurred between 1995 and 2001, while in the agricultural sectors, the tariff reduction occurred after 2001.

A substantial number of papers used CGE models to simulate the effects of China's entry into the WTO on its welfare and on its trade partners' welfare (Bach et al. 1996, Ianchovichina and Martin 2001/ 2003/ 2004, Ianchovichina and Walmsley 2008, Gilbert and Wahl 2002, Walmsley and Hertel 2001). Using such models to study this liberalization event is challenging as the process of liberalization is gradual and involves many aspects. From the results of the CGE literature, the net welfare gains from China's entry into the WTO are considerable, although perhaps overstated in some cases by the failure to accommodate tariff exemption. This research computes that the gains range between 4 billion and 30 billion dollars, which corresponds to an increase in GDP between 0.5 and 2.4 percent. Given inherent uncertainty over specifications, parameters and data, we should be aware of not interpreting CGE results too literally. Moreover, it appears that most of the gains from the liberalization occurred between 1995 and 2001. In the CGE models, it is assumed that there is an immediate response to the shocks and the modification of policies, while per se a policy often takes time to affect behaviours. We believe that our ex-post analysis will permit to study the actual effects and highlight the timing of the impact of the policy.

An ex-post analysis gives a better assessment of the actual effects and can be used for future policy implementation. A decade after the official date of entry, we have a decent perspective about the actual effects of this event on China. In their paper, Arkolakis et al. (2012) proposed a generic measure of the gains from trade that relies on the ex-post observation of the variations of terms-of trade. It is generic in the sense that it embraces all sources of gains from trade. Our analysis applies this formula to measure the aggregate welfare effects of this shock. The methodology we use relies on the comparison of the situation before and after the shock; it requires the definition of a precise time-window. In the NAFTA case, a time-window can be easily defined as in the time frame from December 31st 1993 to January 1st 1994, most of the tariffs between the US, Canada and Mexico were eliminated. However, the time frame of China 's liberalization is more difficult to precise as China's entry into the WTO was a long and gradual process from 1995 to 2005. The official entry is December 11th 2001, but the process of liberalization started a long time before; therefore, defining a starting point is somewhat arbitrary. The CGE literature studying this process agreed on 1995 to be a turning point. The process ended in 2005 with the abolition of the MFN

treatment for China in textiles. We choose to study the welfare gains over the period 1995-2009 to have a mid-term perspective. We also believe that there is might be a delay between the implementation and the impact of a policy. To have a better idea on the timing of effects we divide it into sub-periods. Within the process, we will distinguish the pre-entry period (1995- 2001), the post-entry period (2001-2005), and the post-liberalization period (2005-2009).

Table 1: Import tariffs (in percent)

Sectors	1995	2001	2004	2007
Agriculture	25.15	23.62	7.96	10.97
IAA	27.55	24.75	13.28	11.56
Forestry and Mining	5.42	0.98	0.41	0.32
Industry	40.6	13.97	8.31	6.98
Services	0.03	0.01	0.06	0.01

Source: 1995, GTAP 4; for 2001, 2004, 2007 MacMap [a]

[a] For the year 1995, the tariffs are taken from GTAP 4 hence it relies on a trade-weighted aggregation. This methodology raises some concerns. It weights each tariff line with its share in the overall import of China in a given year, there is an under-estimation of the protection. For the other years, we use MacMap data instead of GTAP. By aggregating from HS-6 to our 5 sectors using the reference group methodology, we correct for the endogeneity bias mentioned previously. This re-aggregation of the tariffs to five sectors might lead to surprising results. According to MacMap tariffs, it appears that the protection has increased between 2001 and 2007 in some sectors while China is supposed to be engaged in a strong trade liberalization reform.

3 Methodology

3.1 Basic Formula

To estimate the gains from Chinese liberalization, ideally, we would like to compare two scenarios: a situation in a given year if the liberalization had occurred, with another one in which the liberalization had not occurred. This is exactly what the CGE models attempt to do. However, such analysis is not feasible for our case. To evaluate the welfare changes resulting from the liberalization of China, as previously stressed, we will extend a formula proposed by Arkolakis et al.(2012). It offers a parsimonious way to evaluate the changes resulting from a foreign shock that holds in a sufficient number of trade models, given some assumptions and macro restrictions. The measure used by Arkolakis et al.(2012) is relevant to evaluate the gains whatever the models (three main trade models) and the underlying mechanisms. They define the foreign shock as any change in labour endowments, entry costs, variable trade costs and fixed costs that do not affect either the country's endowment or its ability to serve its own market. According to this definition, the trade liberalization of China that mostly consists of tariff reductions can be seen as a specific type of foreign shock. The change in real income in the domestic country associated with the

trade liberalization is given by:

Equation 1 [2]

$$\widehat{W} = \widehat{\lambda}^{\frac{1}{\varepsilon}}$$

where W is the real output, which is our measure of welfare; λ is the given country's domestic trade share and ϵ is the trade elasticity [3]. It is important to stress that the hat refers to the ratio of the situation after the liberalization and the situation before the liberalization[4].

The idea behind this formula is that the welfare changes in the country engaged in the liberalization process can be inferred with only two parameters, λ and ε, whatever the trade model considered and the origin of the foreign shock. Another important concern while measuring the impact of a trade liberalization is to find a proper measure of trade barriers (tariffs and non-tariff barriers). These are the keys to examine the extent to which trade was affected. Our methodology circumvents this issue. Under specific assumption and macro restrictions, we are able to recreate the same dynamics as the one in the simple Armington framework. The gains from trade in this model only depend on the terms of trade changes; these changes can be inferred from the changes in the relative demand for goods from different countries.

This methodology requires only two parameters that are available relatively easily and it gives important and elegant results. However, the formula is only valid under some specific assumptions and macro restrictions. These conditions ensure that all the changes in variable trade cost affect welfare through terms of trade changes, as in an Armington trade model.The four necessary primitive assumptions are the following: (i) Dixit-Stiglitz preferences, (ii) one factor of production, (iii) linear cost functions, and (iv) perfect or monopolistic competition. The three macro-level restrictions needed are that: (i) trade is balanced, (ii) aggregate profits are a constant share of aggregate revenues, and (iii) the import demand system is CES [5]. Although these assumptions are admittedly restrictive, they are satisfied in many well-known trade models besides the Armington model, such as Eaton and Kortum (2002), Krugman (1980), and multiple variations and extensions of Melitz (2003) featuring Pareto distributions of firm-level productivity. The results must be analysed with great caution as they are driven by two parameters; the way of measuring these parameters is crucial.

[2] details and proof in Arkolakis et al. (2012)

[3] The trade elasticity is defined as $\varepsilon = \frac{\partial ln(X_{ij}/X_{jj})}{\partial ln \tau_{ij}}$, it is a measure of the sensitivity of imports to a change in trade costs. $\varepsilon < 0$.

[4] $\widehat{X} = \frac{X_{after}}{X_{before}}$

[5] details on these assumptions in Arkolakis et al. (2012)

3.2 Formula for multiple sectors

Understanding the impact of China's entry into the WTO on aggregate welfare is determinant but does not provide much information on the mechanisms and the source of gains. With the previous formula we are not able to analyse the reallocation within countries at either the firm or the sectoral level, as predicted in trade models. Extending the formula to several sectors is necessary to highlight the dynamics by sector. The impact is expected not to be homogeneous across sectors. An aggregate positive effect does not display the great heterogeneity between sectors. Moreover, a multi-sector analysis will allow to use more disaggregated elasticity parameters and hence relax the assumption of the constant ε. Assuming a constant trade elasticity across all sectors is one important drawback of the basic formula. Indeed, it is quite unlikely that ε is constant. Imbs and Méjean (2012) showed that the estimations of trade elasticity at aggregate level suffer from a homogeneity bias and tend to distort the results on welfare.

Arkolakis et al. (2012) consider an extension of their formula to multiple sectors, $s = 1, \ldots, S$, by assuming that the representative agent has a two-tier utility function and applying sector-specific restrictions. The upper tier of the utility function is assumed to be Cobb-Douglas, with consumption shares $0 \leq \eta_s \leq 1$, and the lower tier being Dixit-Stiglitz with elasticity of substitution $\sigma_s < 1$. Moreover we must assume that the three previous macro-level restrictions now hold sector by sector[6]. Contradictory with the previous formula, the formula differs for perfect and imperfect competition. For purpose of simplicity, we focus on the perfect competition setting, keeping in mind that it might lead to an under-estimation of the gains from the liberalization and interpret the results in that sense. In a perfect competition trade model (such as the ricardian model), we expect to have a reallocation between sectors due to the trade liberalization. In a perfect competition setting with multiple sectors, the change in real income in the domestic country associated with the trade liberalization generalizes to:

Equation 2 (MS) [7]

$$\widehat{W} = \prod_{s=1}^{S} \widehat{\lambda}_s^{\frac{\eta_s}{\varepsilon_s}}$$

Hence, within each sector the welfare is as follows:

$$\widehat{W}_s = \widehat{\lambda}_s^{\frac{1}{\varepsilon_s}}$$

[6] details in Arkolakis et al. (2012)

[7] proof of the formula and details can be found in the Appendix of Arkolakis et al.(2012) paper

3.3 Formula for multiple sectors with intermediate goods

In China, a non-negligible part of the trade concerns intermediate goods [8]. However, our model does not allow for intermediate good use in production. The liberalization, not only helped the trade of final goods, we believe it also facilitated the trade of intermediate goods; hence, not taking into account the presence of intermediate goods might bias the results. The reduction in import tariffs occurred in the trade of both types of goods. As a result, we expect a firm to see a reduction in the cost of import of final goods and of intermediaries. Moreover, a large literature showed that domestic firms, which are able to increase the range of the input they use for production through imports, experience an increase in productivity. Hence,the introduction of intermediate goods should magnify the gains from liberalization. The importance of the bias will depend on the share of intermediate goods imported: the more goods one imports for intermediate use, the more one benefits of liberalization. Following the idea of the extension proposed by Arkolakis et al. (2012) to intermediate goods, we derive a formula for welfare gains from trade with multiple sectors and intermediate goods in the case of perfect competition. We allow the goods ω to be used in the production of other goods. There is an additional factor of production (sector specific) that is a composite good[9]. In this environment, the change in real income in the domestic country associated to its own trade liberalization generalizes to:

Equation 3 (MS-IT) [10]

$$\widehat{W} = \prod_{s=1}^{S} \widehat{\lambda}_s^{\frac{\eta_s}{\varepsilon_s \beta_s}}$$

where $1 - \beta_s$ is the share of intermediate goods in variable production costs. Hence, within each sector the welfare is simply equal to:

$$\widehat{W_s} = \widehat{\lambda}_s^{\frac{1}{\varepsilon_s \beta_s}}$$

4 Data

To evaluate the changes in welfare due to Chinese liberalization, we apply the formula (MS) and (MS-IT) described in the previous section. Both formulas rely on two key parameters that are λ and ε.

λ_s is the share of a China's domestic trade share in the sector s. It can be seen as the inverse of the import penetration ratio, hence we calculate it as follows:

$$\lambda_s = 1 - \frac{Imports_s}{GrossOutput_s} \tag{1}$$

[8] half of Chinese export comes from processing trade

[9] refer to the Appendix for details

[10] proof can be found in the Appendix

The values for sectoral gross output and imports can easily be retrieved from an Input-Output (IO) table. We choose to use the Chinese National Input-Output table from the WIOD database. It gives National Input-Output table for a sample of country, including China, from 1995 to 2009 at the level of 35 sectors[11]. It allows us to compute λ_s for 35 sectors and the years of interest 1995, 2001, 2005 and 2009. In what follows, s will be defined as a sector in the National Input-Output table ($s = 1, \ldots, 35$).

Using IO tables is convenient as it ensures that $GrossOutput_s$ and $Imports_s$ are expressed at the same level of disaggregation and in the same unit, but also since it allows us to compute the additional parameters needed for the extensions η_s and β_s. To build these parameters we use Chinese National Input-Output table in 1995 to ensure exogeneity. Indeed, these parameters are assumed not to be influenced by the trade liberalization.

η_s represents the consumption share associated to the sector s in our Cobb-Douglas utility, we can retrieve it from Chinese National Input-Output table using the information on final consumption expenditure by households at the sector level.

β_s in our formula governs the division in production cost between the two production factors, labour and intermediate goods. β_s represents the share dedicated to labour, while $(1 - \beta_s)$ represents the share dedicated to intermediate goods. For exposition purpose, we define α_s as the share of intermediate consumption in and variable costs of production: $\alpha_s = 1 - \beta_s$. It can be calculated using the information in National Input-Output table. According to the relations in the IO table, we can define a matrix A of coefficients $\alpha_{i,j}$ as follows :

$$A = Am.(I - Ad)^{-1} \tag{2}$$

where Am is the matrix of technical coefficient of production for imports, Ad is the matrix of technical coefficients of domestic input and I is the identity matrix. Am and Ad are the main components of the IO table. The share of intermediate consumption in costs of production equals:

$$\alpha_s = \sum_{i=1}^{S} \alpha_{i,j} \tag{3}$$

where i and j stand for the 35 sectors.

Lastly, we have to find a measure of ε_s. The measure of this parameter drives all the results. Ideally, we would like to estimate 35 elasticity coefficients corresponding to our 35 sectors (as defined in WIOD).

[11] sectors are defined as a re-aggregation of NACE divisions. Details of the nomenclature can be found in Eurumban et al. (2011)

However, such estimation goes beyond the scope of this paper. We use existing estimation for ε_s instead. The existing estimations have to follow two conditions: (i) the estimation of ε must be done at sectoral level (ii) the sectoral level used for the estimation must match with our definition of sector. Most of the estimations of trade elasticities in the literature are done at an aggregate level (Eaton and Kortum 2002, Costinot et al. 2012 and Simonovska and Waugh 2011), thus the first requirement severely restricts the sample of estimations available. In addition, none of the existing estimations at sectoral level are using the same disaggregation as the one used in WIOD. Hence, we must combine different sources and proceed to re-aggregation to have proper estimations of the ε_s. We are aware that this is not the best method, but it is the most suitable one considering the different constraints we are facing.

The most appropriate estimations available are the one provided by Kee, Nicita and Olarreaga (2008). They estimate trade elasticities at 3-digit International Standard Industrial Classification (ISIC) revision 2 for 28 manufacturing sectors for 100 countries including China. They adopt a semi flexible translog GDP function to formally derive import demands and their elasticities. Their estimations of elasticities are based on data on prices and endowments. Using a matching of ISIC and the disaggregation used in WIOD, we are able to recover most of the coefficients. We still face two problems: (i) the values for the elasticities are only estimated for industrial sector which represents 14 out of 35 sectors; (ii) several values at ISIC correspond to one sector in WIOD definition of sector. The cleanest way to re-aggregate is to re-aggregate from ISIC to WIOD weighting the coefficients at ISIC by the share of each ISIC industry in Chinese imports to the rest of the world in 1995. The weights are calculated using BACI trade database (Gaulier and Zignago 2010). Missing elasticities are mostly in services. Estimations of trade elasticities in services are not commonly available in the literature. Such elasticities are used in simulation procedure, GTAP database(source) provide estimation of Armington elasticities of substitution between domestic and foreign goods. In such model, the trade elasticity is defined as the inverse of the elasticity of substitution, hence we can recover ε_s with Armington elasticities. The estimations are precise for agricultural sectors, we need to re-aggregate the coefficients from GTAP sectors to our sectors. To do so, we use the same methodology as before, weighting each coefficient by the share of each GTAP sector in Chinese imports to the rest of the world in 1995 using CHELEM database (CEPII). For the services, the estimations are less precise, there is only two different coefficients for all the services, but it is the best estimation for service elasticities available to our knowledge.

5 Results

5.1 Aggregated Welfare Gains

This methodology is simple to implement and give plausible results, but we have to bear in mind that our computation of welfare relies on restrictive assumptions and the results highly depend on the value of our key parameters. As λ is observable its measure is not really a concern. On the other hand, as we stressed in Section 4, the measure of the trade elasticity ε is imprecise which might lead to inaccurate results. For this reason, we won't discuss in detail the results for the service sectors.

Table 2: Aggregated Welfare variation in percent

Formula	1995-2001	2001-2005	2005-2009	2001-2009	1995-2009
Welfare (MS)	-0.21	0.94	-0.26	0.68	0.47
Welfare (MS-IT)	-0.22	1.17	-0.38	0.78	0.56

The results presented in Table 2 give an idea of the sign and the magnitude of the gains. As we explained in the first section, we focused on the period from 1995 to 2009. It aims at having an ex-ante analysis of the mid-term gains of the liberalization. Then, to have a more precise look at the trend and the timing of the effects we divide the process of liberalization into several sub-periods. In Table 2, as in all the tables of this section, the impact on welfare is presented as a percentage change in welfare during the period of interest. For example, the value on the column 1995-2001 are $\frac{W_{2001}-W_{1995}}{W_{1995}} = \frac{W_{2001}}{W_{1995}} - 1$. The first line presents the results for the welfare using the Equation 2 (MS) while the second line presents the results for the welfare using the Equation 3 (MS-IT), taking into account intermediate goods in production. The difference between these two specifications at the aggregate level is negligible, but, as expected, the gains from trade are magnified by the inclusion of intermediate goods in production. At a sectoral level, this difference is expected to be more significant, especially for the sectors in which the share of intermediate goods in production costs is important. The aggregated welfare gains of Chinese liberalization process over the whole period (1995-2009) are quite important. For both specification they are about half of a percent of real income, which is in line with the results obtained in CGE models.

As mentioned in Section 2, the process of liberalization was gradual, thus we examine the impact over sub-periods. Most of the liberalization occurred between 1995-2001. In CGE models, most of the gains occurred in this period. However, in our estimation it is not the case; the greatest gains are between 2001 and 2005. One of the caveats of the CGE models is to assume that the shock affects all the equilibrium equations as soon as it takes place. Therefore, the time of the shock is also the time of the impact. How-

ever, for China there might be a delay between implementation of the policy and its actual impact on the economy. The massive tariff reduction that occurred between 1995 and 2001 did not have an immediate impact on the relative demand for foreign goods, hence on welfare. According to our formula, the change in welfare can be interpreted as a change in the relative demand for domestic goods. Between 1995 and 2001, the relative demand for domestic goods increased, which in our results translates as a decrease in welfare. Between 2001 and 2005, the agents responded to the shock by a significant decrease in the relative demand for domestic goods, and as a results welfare increased. The decrease of welfare between 2005 and 2009 might just be the sign of a stabilisation in the consumption behaviour of the population after the shock .

5.2 Welfare Gains by sector

In the Appendix, we present the Tables for the effects on welfare at a sectoral level. The Table A.2 contains the results derived from the Equation 2 with multiple sectors (MS) while the Table A.3 contains the results derived from the Equation 3 for multiple-sectors including intermediate goods in production (MS-IT). The magnitude of the gains changes from one table to the other, but the sign of the effect does not. While interpreting the results by sectors, we have to bear in mind that our formulas for multiple sectors (MS and MS-IT) are valid for perfect competition models of trade.

In this type of trade models, the gains from trade come from reallocation of resources between sectors. Trade is triggered by the difference of productivity across countries. With trade openness, in a world with no trade cost (as in Ricardo's model), each country will choose to buy a given good ω from the cheapest source available, that is to say from the most efficient country. In terms of welfare, the country will gain in the sector in which is not efficient relatively to others and will loose in the rest of the sectors. As a reduction of tariff facilitates the access to foreign goods, a trade liberalization can be seen as a way to get closer to the ideal world with no trade cost . With the liberalization, the previous reallocation should occur. In the case of China's liberalization, we expect that, it experiences a gain in the sector in which it is relatively less productive than its trade partners and a loss in sector in which it is relatively more productive.

For the interpretation of the results, we will focus on the impact on welfare on the whole period 1995-2009 (column 5 of the Tables A.2 and A.3). Among the 35 sectors studied, 23 sectors seem to gain from the liberalization while 9 sectors experience a loss. In 2 sectors, the liberalization did not have an impact. The results for the sector "Coke, refined petroleum and nuclear fuel" seems quite puzzling. The trade in

this sector is problematic and does not seem to follow any rational path. To test if the reallocation among sectors fits the intuitions derived from the theoretical models, we look at the sector that experienced a loss, among these 9 sectors 5 are services. As we have some concerns about the results for the service sectors, we will only focus on the 4 remaining sectors: "Textiles and Textile Products" , "Leather, Leather and Footwear" , " Wood and Products of Wood and Cork" and " Manufacturing, nec; Recycling ". According to the model, we expect these sectors to be sectors in which China had a comparative advantage before the liberalization.

To measure comparative advantage we use a new theoretically-consistent measure of Ricardian Revealed Comparative Advantage exposed in a forthcoming CEPII's working paper (Leromain and Orefice 2013). This index is built on Costinot et al. (2012). It is able to isolate the exporter specific factors driving trade flows, and thus it fits better the original idea of Ricardian comparative advantage. Relying on an econometric technique, the new RCA index is therefore clean for partner country and sector specific factors that may affect ex-post trade flows and thus the traditional Balassa Index. This index has been computed for two levels of disaggregation, we will use the index at HS-2. It is defined such that: if $index_{ik} > 0$, the country i has a comparative advantage in the sector k. The Table 2 offers a list of the HS-2 for which China had a comparative advantage in 1995. The HS-2 are ranked according to the value of the RCA index. A higher value denotes a greater comparative advantage. What is striking from this list is that most of the HS-2 belong to the sectors listed above. As a result of the liberalization, China did lose from the four sectors in which it had a comparative advantage in 1995.

Table 3: RCA Index for China in 1995

HS2	description	RCA index
46	Manufactures of straw, of esparto or of other plaiting materials; basket-ware and wickerwork	1.96
66	umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding-crops and parts thereof	1.84
67	prepared feathers and down and articles made of feathers or of down ; artificial flowers	1.78
95	Toys, games and sports requisites ; parts and accessories thereof	1.49
42	Articles of leather ; saddler and harness ; travel goods, handbags and similar containers;	1.49
61	Articles of apparel and clothing accessories, knitted or crocheted	1.47
65	headgear and parts thereof	1.46
62	Articles of apparel and clothing accessories, not knitted or crocheted	1.44
64	Footwear, gaiters and the like ; parts of such articles	1.44
50	Silk	1.41
91	Clocks and watches and parts thereof	1.41
63	Other made-up textiles articles ; sets ; worn clothing and worn clothing and worn textiles articles ; rags	1.36
80	Tin and articles thereof	1.32
36	Explosives ; pyrotechnic products ; matches ; pyrophoric alloys ; certain combustible	1.31
96	Miscellaneous manufactured articles	1.25
81	Other base metals ; cermets ; articles of thereof	1.24
69	Ceramic products	1.23
83	Miscellaneous articles of base metal	1.17
53	Other vegetable textile fibres ; paper yarn and woven fabrics or paper yarn	1.16
57	Carpets and other textile floor coverings	1.16
58	Special woven fabrics ; tufted textile fabrics ; lace ; tapestries ; trimmings ; embroidery	1.16
94	Lamps and lighting fitting, not elsewhere specified or included ...; prefabricated buildings	1.15
82	Tools, implements, cutlery, spoons and forks, of base metal; parts therof of base metal	1.14
52	Cotton	1.14
92	Musical instruments; parts and accessories of such articles	1,13
55	man-made staple fibres	1.13
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth	1.09
43	Furskins and artificial fur ; manufactures thereof	1.08
60	Knitted or crocheted fabrics	1.08
79	Zinc and articles thereof	1.07
25	Salt ; sulphur, earths and stone ; plastering materials, lime and cement	1.05
85	Electrical machinery and equipment and parts thereof ; sound recorders and reproducers,	1.04
29	Organic chemicals	1.00

Source: RCA database, CEPII

6 Concluding remarks

In this paper we tried to fill in the gap in the literature studying the welfare effect of China's entry into the WTO by implementing an ex-post analysis of this event. To do so, we used a formula introduced by Arkolakis et al. (2012) that permits to assess the impact of a foreign shock on welfare in a wide range of trade models. We tried to make it as accurate as possible to the case of Chinese liberalization by using extensions of the basic formula. We found that Chinese liberalization had a non negligible impact on welfare. Over the whole period considered (1995-2009), the welfare increased by about half percent due to the liberalization. Whatever the formula used, this assessment of the impact of the liberalization on welfare depends on two parameters that are the share in the expenditure dedicated to domestic goods and the trade elasticity. The measure of the first parameter is not problematic because it is observable. The measure of the second parameter is quite problematic. This measure is the product of an estimation. As we stressed in the Section 4 of our paper, the coefficients we used for this parameter are quite imprecise. Hence, we believe that the results, even though not invalid, suffer from this imprecision. For further research, it might be interesting to re-estimate properly the sectoral trade elasticities for the 35 sectors of interest for the case of China. This could be done using the methodology developed by Caliendo and Parro (2012). Their estimations are based on a gravity equation using tariff data. However, our main concern remains concerning the service sectors, because such data are not quite available for these sectors.

Bibliography

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2012. "New Trade Models, Same Old Gains" American Economic Review 102 (1) (February): 94–130.

Broda, Christian, and David E. Weinstein. 2006. "Globalization and the Gains from Variety." Quarterly Journal of Economics 121(2): 541–585.

Bach, Christian F., Will Martin, and Jennifer A. Stevens. 1996. "China and the WTO: Tariff Offers, Exemptions, and Welfare Implications." Weltwirtschaftliches Archiv 132 (3): 409–431.

Caliendo, Lorenzo, and Fernando Parro. 2012. "Estimates of the Trade and Welfare Effects of NAFTA" NBER Working Paper 18508.

Costinot, Arnaud, Dave Donaldson, and Ivana Komunjer. 2012."What Goods Do Countries Trade? A Quantitative Exploration of Ricardo's Ideas." The Review of Economic Studies 79 (2): 581–608.

Dixit, Avinash K., and Joseph E. Stiglitz. 1977. "Monopolistic Competition and Optimum Product Diversity."The American Economic Review 67 (3): 297–308.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." Econometrica 70 (5): 1741–1779.

Erumban, Abdul Azeez, Reitze Gouma, Bart Los, Robert Stehrer, Umed Temurshoev, Marcel Timmer, and Gaaitzen de Vries. 2011."World Input-Output Database (WIOD): Construction, Challenges and Applications." In Paper Presented at the DIME Final Conference, 6:8.

Feenstra, Robert C. 1994. "New Product Varieties and the Measurement of International Prices" American Economic Review 84(1): 157–177.

Gaulier, Guillaume, and Soledad Zignago. 2010. "BACI: International Trade Database at the Product-Level (the 1994-2007 Version)." CEPII Working Paper, 2010 (23)

Gilbert, John, and Thomas Wahl. 2002. "Applied General Equilibrium Assessments of Trade Liberalisation in China." The World Economy 25 (5): 697–731.

Ianchovichina, Elena, and Will Martin. 2001. "Trade Liberalization in China's Accession to WTO." Journal of Economic Integration 16 (4): 421–446.

———. 2003. Economic Impacts of China's Accession to the World Trade Organization. Vol. 3053. World Bank Publications.

———. 2004. "Impacts of China's Accession to the World Trade Organization." The World Bank Economic Review 18 (1): 3–27.

Ianchovichina, Elena, and Terrie Walmsley. 2008. "Impact of China's WTO Accession on East Asia." Contemporary Economic Policy 23(2): 261–277.

Imbs, Jean, and Isabelle Méjean. 2010. "Trade Elasticities." Paris School of Economics, Unpublished

Mimeo.

Kee, Hiau Looi, Alessandro Nicita, and Marcelo Olarreaga. 2008. "Import Demand Elasticities and Trade Distortions." The Review of Economics and Statistics 90 (4): 666–682.

Kehoe, Timothy J. 2003. "An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA." Levine's Working Paper Archive 506439000000000525. David K. Levine.

Krugman, Paul. 1980. "Scale Economies, Product Differentiation, and the Pattern of Trade." The American Economic Review 70 (5): 950–959.

Leromain, Elsa, and Gianluca Orefice. 2013"New Revealed Comparative Advantage Index: Dataset and Empirical Distribution" CEPII Working Paper forthcoming.

McDougall, R.A., A. Elbehri, and T.P. Truong. 1998." Global Trade Assistance and Protection: The GTAP 4 Data Base" Center for Global Trade Analysis, Purdue University

Melitz, Marc J. 2003. "The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity." Econometrica 71 (6): 1695–1725.

Reimer, Jeff, and Thomas Hertel. 2003."International Cross Section Estimates of Demand for Use in the GTAP Model." GTAP Working Papers 22.

Romalis, John. 2007. "NAFTA's and CUSFTA's Impact on International Trade." The Review of Economics and Statistics 89 (3): 416–435.

Simonovska, Ina, and Michael E. Waugh. 2011. "The Elasticity of Trade: Estimates and Evidence." National Bureau of Economic Research.

Trefler, Daniel. 2004."The Long and Short of the Canada-U.S. Free Trade Agreement.". American Economic Review 94 (4): 870–895.

Walmsley, Terrie L., and Thomas W. Hertel. 2001. "China's Accession to the WTO: Timing Is Everything." The World Economy 24(8): 1019–1049.

A Appendix

A.1 Extension to multiple sectors with intermediate goods

The extension to multiple sectors with intermediate goods is built on the extensions presented in our benchmark paper. In what follows we will present the 3 primitive assumptions and the 3 macro-restrictions needed for the formula to hold.

A.1.1 Assumptions

Preferences: The assumption on preferences is the same as the one in the extension to multiple sectors in our benchmark paper. As noticed by Arkolakis et al.(2012), it is standard to interpret the models with Dixit-Stiglitz preferences as one sector model with a continuum of varieties. Under this interpretation, the model can be extended to multiple sectors $s = 1, \ldots, S$ by assuming that the representative agent has a two-tier utility function; the upper-tier being a Cobb-Douglas with consumption shares $0 \leq \eta_s \leq 1$, and the lower tier being Dixit-Stiglitz with elasticity of substitution $\sigma_s < 1$. Under this assumption, the consumer price index in country i [12] formally becomes:

$$P_i = \prod_{s=1}^{S} (P_{is})^{\eta_s}$$

where $P_{is} = \left(\int_{\omega \in \Omega_s} p_{is}(\omega)^{1-\sigma_s} \mathrm{d}\omega \right)^{\frac{1}{1-\sigma_s}}$ is the Dixit-Stiglitz price index associated with variety from sector s.

Market structure: For a matter of simplicity, we focus on the case of perfect competition.

Technology: We modify the assumption compare to the extension to multiple sectors to allow for intermediate goods. The goods $\omega \in \Omega_s$ can be used in the production of other goods. Formally, we assume that all goods at a sectoral level can be aggregated into a unique intermediate good P_{is} using the same Dixit-Stiglitz aggregator as for consumption within a sector. Thus, P_{is} now represents both the consumer price index on a given sector and the price of intermediate goods in this sector in the country i. The cost function for each good $\omega \in \Omega_s$ is given by:

$$C_{is}(w, P, q, t, \omega) = \sum_{j=1}^{n} c_{ijs}(w_i, P_{is}, t_j, \omega) q_j$$

where i denotes the country in which the good is produced and j denotes the importing country. $P = \{P_{is}\}$ is the vector of intermediate good prices in the sector s.
In line with our benchmark paper, we further assume that constant marginal cost can be written as:

$$c_{ijs}(w_i, P_{is}, t_j, \omega) = \tau_{ijs}.w_i^{\beta_s}.P_{is}^{1-\beta_s}.\alpha_{i,j}(\omega).t^{\frac{1}{1-\sigma_s}}$$

with $\beta_s \in [0, 1]$, share of labour in variable production costs.

A.1.2 Macro Level Restrictions

The first two macro restrictions are similar to the one for the MS case in the benchmark paper:

[12] We assumed there are n countries in the model

R1(MS-IT) *For any country j and any sector s,* $w_j L_{js} + \Pi_{js} - w_j N_{js} F_{js} = \sum_{i=1}^{n} X_{jis}$

R2(MS-IT) *For any country j and any sector s,* $\Pi_{js} = \zeta P_{js}$ with $\zeta \in [0,1]$

R3(MS-IT) *The import demand system is such that for any sector s, any importer j and any pair of exporters* $i \neq j$ *and* $i' \neq j, \varepsilon_{jsii'} = \varepsilon_s < 0$ *if* $i = i'$ *and zero otherwise, with* $\varepsilon_{jsii'} = \frac{\partial \ln(\frac{X_{ijs}}{X_{jjs}})}{\partial \ln \tau_{i'js}}$

The only difference with R3 (MS) is that the import demand system now refers to the mapping from $(\mathbf{w}, \mathbf{P}_s, \mathbf{N}_s, \tau_\mathbf{s})$ into $\mathbf{X}_s$ and, so the partial elasticities $\varepsilon_{jsii'}$ also hold fixed the price of intermediate goods in the sector s.

A.2 Proof

A.2.1 Preliminary

The proof of the basic formula and the formula extended to multiple sectors can be found in the Appendix of Arkolakis et al.(2012), we will develop here the proof of the formula extended to multiple sectors and intermediate goods building on the proof in the benchmark paper. We focus on the steps of the proof that differ from the case provided in the Appendix of the original paper. For a matter of simplicity, we use the same notation as the benchmark paper. We use, as well, labor in country j as our numeraire, $w_j = 1$.
Throughout this appendix, for any importing country j, we denote by $G_j(\alpha_1, \ldots, \alpha_n, \phi_1, \ldots, \phi_n)$ the share of goods $\omega \in \Omega$ such that $\alpha_{ij}(\omega) \leq \alpha_i$ and $\phi_{ij}(\omega) \leq \phi_i$ for all i, and $g_j(\alpha_1, \ldots, \alpha_n, \phi_1, \ldots, \phi_n)$ the associated density function. We are only considering here the proof for the case of perfect competition.

Under perfect competition, it is convenient to use the following additional notations:

$$c_{ijs} = w_i^{\beta_s} P_{is}^{1-\beta_s} \tau_{ij} \tag{A1}$$

$$g_{ijs}(\alpha_1, \ldots, \alpha_n, c_{1js}, \ldots, c_{njs}) = \int_{\alpha_1 > \frac{\alpha_i c_{ijs}}{c_{1js}}} \cdots \int_{\alpha_{i-1} > \frac{\alpha_i c_{ijs}}{c_{i-1js}}} \int_{\alpha_{i+1} > \frac{\alpha_i c_{ijs}}{c_{i+1js}}} \cdots \int_{\alpha_n > \frac{\alpha_i c_{ijs}}{c_{njs}}} g_j(\alpha, \mathbf{0}) \mathrm{d}\alpha_{-i} \tag{A2}$$

where $\alpha = (\alpha_1, \ldots, \alpha_n)$, $\mathbf{0} = (0, \ldots, 0)$ and α_{-i} denotes the vector α with the i-th component removed.
In order to establish the formula, first we have to assume that Lemma 1 applies within sector. Considering our definition of price index within sector (similar to the one of aggregate price index in a one sector model), the generalization within sector seems accurate. The Lemma 1 applied to (MS-IT) characterizes the consumer price index in a given sector s, P_{js}, and the share of expenditure, λ_{ijs}, on goods from country i in country j in sector s under perfect competition.

Lemma 1 (MS-IT)

$$P_{js} = \left[\sum_{i=1}^{n} \int_0^{+\infty} (c_{ijs}\alpha_i)^{1-\sigma_s} \bar{N} g_{ijs}(\alpha_i, c_{1js}, \ldots, c_{njs}) \mathrm{d}\alpha_i \right]^{\frac{1}{1-\sigma_s}} \tag{A3}$$

$$\lambda_{ijs} = \frac{\int_0^{+\infty} (c_{ijs}\alpha_i)^{1-\sigma_s} g_{ijs}(\alpha_i, c_{1js}, \ldots, c_{njs}) \mathrm{d}\alpha_i}{\sum_{i'=1}^{n} \int_0^{+\infty} (c_{i'js}\alpha_{i'})^{1-\sigma_s} g_{i'js}(\alpha_{i'}, c_{1js}, \ldots, c_{njs}) \mathrm{d}\alpha_{i'}} \tag{A4}$$

A.2.2 Proof

We follow the steps fo the proof in the Appendix of Arkolakis et al.(2012)

Step 1: small changes in real income in country j satisfy

$$d\ln W_j = -\sum_{s=1}^{S} \eta_{sj}.d\ln P_{js} \tag{A5}$$

Indeed, by definition: $d\ln W_j = d\ln Y_j - d\ln P_j$. By labor market clearing and the representative agent's budget constraint: $d\ln Y_j = d\ln w_j$, and we know by the choice of our numeraire that $d\ln w_j = 0$. Hence $d\ln W_j = -d\ln P_j$. By the definition we have $P_j = \prod_{s=1}^{S}(P_{js})^{\eta_s}$, total differenting this expression gives $d\ln P_j = -\sum_{s=1}^{S}\eta_{sj}d\ln P_{js}$.

Step 2: small changes in consumer price index in sector s satisfy

$$d\ln P_{js} = -\sum_{i=1}^{n} \lambda_{ijs} d\ln c_{ijs} \tag{A6}$$

Indeed, by Lemma 1(MS-IT) we know that the consumer price index at the level of sector is given by equation (A3). Totally differentiating the expression we obtain:

$$d\ln P_{js} = (\frac{1}{1-\sigma_s}).\sum_{i=1}^{n}\lambda_{ijs}\left[(1-\sigma_s)d\ln c_{ijs} + \sum_{i'=1}^{n}\gamma_{ijs}^{i'}d\ln c_{i'js}\right] \tag{A7}$$

where

$$\gamma_{ijs}^{i'} = \frac{\partial \ln(\int_0^{+\infty}\alpha_i^{1-\sigma_s}g_{ijs}(\alpha_i, c_{1js},\ldots,c_{njs})\mathrm{d}\alpha_i}{\partial \ln c_{i'js}}$$

By equation (A2), the extensive margin elasticities by sector satisfy $\gamma_{ijs}^{i} = -\sum_{i'\neq i}\gamma_{ijs}^{i'}$. Thus, we can rewrite equation (A7) as

$$d\ln P_{js} = \sum_{i=1}^{n}\lambda_{ijs}d\ln c_{ijs} + (\frac{1}{1-\sigma_s}).\sum_{i=1}^{n}\sum_{i'\neq i}\lambda_{ijs}\gamma_{ijs}^{i'}(d\ln c_{i'js} - d\ln c_{ijs}) \tag{A8}$$

To conclude, note that by equation (A2), the extensive margin elasticities by sector also satisfy $\lambda_{ijs}\gamma_{ijs}^{i'} = \lambda_{i'js}\gamma_{i'js}^{i}$, which implies

$$\sum_{i=1}^{n}\sum_{i'\neq i}\lambda_{ijs}\gamma_{ijs}^{i'}(d\ln c_{i'js} - d\ln c_{ijs}) = 0 \tag{A9}$$

Combining the two previous equations (A8, A9) we obtain equation (A6)

Step 3-4: Small changes in the consumer price index in sector s satisfy

$$d\ln P_{js} = -\frac{d\ln \lambda_{jjs}}{\varepsilon_s\beta_s} \tag{A10}$$

By Lemma 1 (MS-IT), we know that shares of expenditure in a sector s are given by equation (A4). Totally differentiating this expression, we get

$$d\ln\lambda_{ijs} - d\ln\lambda_{jjs} = (1-\sigma_s+\gamma^i_{ijs}-\gamma^i_{jjs})d\ln c_{ijs} + \sum_{i'\neq i}(\gamma^{i'}_{ijs}-\gamma^{i'}_{jjs})d\ln c_{i'js} - (1-\sigma_s-\gamma^j_{ijs}\gamma^j_{jjs})d\ln c_{jjs} \tag{A11}$$

where $\gamma^{i'}_{ijs}$ is defined as previously.
Combining this equation with (A6) we have:

$$d\ln P_{js} = -\sum_{i=1}^{n}\lambda_{ijs}\frac{d\ln\lambda_{ijs} - d\ln\lambda_{jjs} - \sum_{i'\neq i}(\gamma^{i'}_{ijs}-\gamma^{i'}_{jjs})d\ln c_{i'js} + (1-\sigma_s-\gamma^j_{ijs}\gamma^j_{jjs})d\ln c_{jjs}}{1-\sigma_s+\gamma^i_{ijs}-\gamma^i_{jjs}} \tag{A12}$$

Following the same logic as in Appendix A of the benchmark paper (step 4), it is easy to check that equation (A4) and R3(MS-IT) imply $1-\sigma_s+\gamma^i_{ijs}-\gamma^i_{jjs}=\varepsilon_s$, for all $i\neq j$, and $\gamma^{i'}_{ijs}=\gamma^i_{jjs}$ for all $i'\neq i,j$. Combining this observation with the previous equation, we get

$$d\ln P_{js} = -\frac{d\ln\lambda_{jjs}}{\varepsilon_s} + \sum_{i=1}^{n}\lambda_{ijs}\frac{(1-\sigma_s-\gamma^j_{ijs}\gamma^j_{jjs})d\ln c_{jjs}}{\varepsilon_s} \tag{A13}$$

Using the definition of $\gamma^{i'}_{ijs}$, it is easy to check that $\gamma^j_{ijs} = -\sum_{i'\neq j}\gamma^{i'}_{ijs}$ and $\gamma^j_{jjs} = -\sum_{i'\neq j}\gamma^{i'}_{jjs}$, which implies

$$1-\sigma_s-\gamma^j_{ijs}-\gamma^j_{jjs} = 1-\sigma_s+\gamma^i_{ijs}-\gamma^i_{jjs}+\sum_{i'\neq i,j}(\gamma^{i'}_{ijs}-\gamma^{i'}_{jjs}) = \varepsilon_s$$

Together with equation (A13), the previous expression further implies

$$d\ln P_{js} = -\frac{d\ln\lambda_{jjs}}{\varepsilon_s} + d\ln c_{jjs}$$

By definition of c_{jjs} and our choice of numeraire, we know that $d\ln c_{jjs} = (1-\beta_s)d\ln P_{js}$. Thus small changes in the consumer price index in sector s satisfy:

$$d\ln P_{js} = -\frac{d\ln\lambda_{jjs}}{\varepsilon_s\beta_s}$$

Step 5: Combining the previous equation with the welfare definition and integrating as in the Step 5 of the Appendix of the benchmark paper we get Proposition 3:

$$\widehat{W} = \prod_{s=1}^{S}\widehat{\lambda}_s^{\frac{\eta_s}{\epsilon_s\beta_s}}$$

Table 1: Trade Elasticity

Sectors	ε_s
Agriculture, Hunting, Forestry and Fishing	-4.81
Mining and Quarrying	-12.17
Food, Beverages and Tobacco	-4.47
Textiles and Textile Products	-1.01
Leather, Leather and Footwear	-1.01
Wood and Products of Wood and Cork	-0.76
Pulp, Paper, Printing and Publishing	-1.43
Coke, Refined Petroleum and Nuclear Fuel	-0.87
Chemicals and Chemical Products	-1.01
Rubber and Plastics	-1.05
Other Non-Metallic Mineral	-0.68
Basic Metals and Fabricated Metal	-0.99
Machinery, nec	-1.00
Electrical and Optical Equipment	-1.19
Transport Equipment	-0.99
Manufacturing, nec ; Recycling	-1.03
Electricity, Gas and Water Supply	-4.60
Construction	-2.80
Sales, Maintenance and Repair of Motor Vehicules and Motorcycles	-2.80
Wholesale Trade and Commission Trade, Except of Motor Vehicules	-2.80
Retail Trade, Except of Motor Vehicules and Motorcycles ; Repair of HH goods	-2.80
Hotel and restaurant	-2.80
Inland Transport	-2.80
Water Transport	-2.80
Air Transport	-2.80
Other supporting and Auxiliary Transport Activities ; Activities of Travel Agencies	-2.80
Post and Telecommunications	-2.80
Financial Intermediation	-2.80
Real Estate Activities	-2.80
Renting of M & Eq and Other Business activities	-2.80
Public Administration and Defence ; Compulsory Social Security	-2.80
Education	-2.80
Health and Social Work	-2.80
Other Community, Social and Personal Services	-2.80
Private Households with Employed Persons	-2.80

Source: Author's calculations from Kee et al. and GTAP Database

Table 2: Welfare Gains by Sector using Formula 2 (MS)

Sectors	1995-2001	2001-2005	2005-2009	2001-2009	1995-2009
Agriculture, Hunting, Forestry and Fishing	-0.03	0.13	-0.03	0.10	0.07
Mining and Quarrying	-0.08	0.37	0.11	0.48	0.40
Food, Beverages and Tobacco	-0.62	1.01	0.44	1.45	0.83
Textiles and Textile Products	-0.78	-1.03	-2.13	-3.14	-3.89
Leather, Leather and Footwear	-2.29	-0.45	-2.63	-3.07	-5.28
Wood and Products of Wood and Cork	-5.12	2.35	-0.94	1.38	-3.80
Pulp, Paper, Printing and Publishing	-0.54	0.88	0.703	1.59	1.04
Coke, Refined Petroleum and Nuclear Fuel	5.74	21.50	10.71	34.52	42.23
Chemicals and Chemical Products	0.83	3.33	-0.42	2.90	3.75
Rubber and Plastics	-0.99	2.83	-1.52	1.27	0.27
Other Non-Metallic Mineral	0.60	1.72	0.17	1.88	2.50
Basic Metals and Fabricated Metal	0.33	5.00	1.79	6.88	7.23
Machinery, nec	0.06	5.33	-1.43	3.82	3.88
Electrical and Optical Equipment	1.72	9.18	-5.18	3.53	5.31
Transport Equipment	-1.01	4.12	-0.84	3.25	2.21
Manufacturing, nec ; Recycling	-1.96	0.75	-0.51	0.24	-1.73
Electricity, Gas and Water Supply	-0.06	0.42	0.27	0.69	0.64
Construction	0.36	0.40	-0.37	0.02	0.40
Sales, Maintenance and Repair of Motor Vehicules and Motorcycles	0	0	0	0	0
Wholesale Trade and Commission Trade, Except of Motor Vehicules	-0.17	0.25	0.10	0.34	0.17
Retail Trade, Except of Motor Vehicules and Motorcycles ; Repair of HH goods	-0.17	0.25	0.10	0.34	0.17
Hotel and restaurant	0.27	0.33	0.10	0.44	0.17
Inland Transport	-0.31	0.33	-0.03	0.30	-0.01
Water Transport	-0.54	0.25	0.10	0.35	-0.20
Air Transport	-0.14	0.95	0.74	1.69	1.55
Other supporting and Auxiliary Transport Activities ; Activities of Travel Agencies	-0.65	0.83	0.03	0.85	0.20
Post and Telecommunications	0.66	0.62	-0.71	-0.10	0.56
Financial Intermediation	-0.35	0.28	0.05	0.32	-0.02
Real Estate Activities	0.01	0.39	-0.13	0.26	0.27
Renting of MandEq and Other Business activities	-1.67	1.44	-0.72	0.72	-0.96
Public Administration and Defence ; Compulsory Social Security	-0.62	0.35	0.11	0.46	-0.16
Education	-0.31	0.81	0.13	0.94	0.63
Health and Social Work	-0.13	0.80	-0.53	0.26	0.13
Other Community, Social and Personal Services	0.07	0.56	-0.32	0.24	0.30
Private Househols with Employed Persons	0	0	0	0	0

Source: Author's calculations

Table 3: Welfare Gains by Sector using Formula 3 (MS-IT)

Sectors	1995-2001	2001-2005	2005-2009	2001-2009	1995-2009
Agriculture, Hunting, Forestry and Fishing	-0.04	0.14	-0.03	0.11	0.07
Mining and Quarrying	-0.09	0.41	0.12	0.53	0.44
Food, Beverages and Tobacco	-0.66	1.08	0.47	1.55	0.88
Textiles and Textile Products	-0.99	-1.31	-2.71	-3.99	-4.94
Leather, Leather and Footwear	-3.03	-0.59	-3.48	-4.05	-6.96
Wood and Products of Wood and Cork	-6.29	2.92	-1.17	1.72	-4.68
Pulp, Paper, Printing and Publishing	-0.64	1.04	0.83	1.88	1.23
Coke, Refined Petroleum and Nuclear Fuel	8.17	31.57	15.42	51.86	64.27
Chemicals and Chemical Products	1.00	4.03	-0.50	3.51	4.55
Rubber and Plastics	-1.24	3.58	-1.91	1.61	0.34
Other Non-Metallic Mineral	0.65	1.86	0.18	2.05	2.71
Basic Metals and Fabricated Metal	0.39	5.93	2.12	8.18	8.60
Machinery, nec	0.07	6.29	-1.68	4.51	4.58
Electrical and Optical Equipment	2.51	13.62	-7.44	5.17	7.81
Transport Equipment	-1.21	4.94	-1.00	3.90	2.64
Manufacturing, nec ; Recycling	-2.37	0.91	-0.62	0.28	-2.09
Electricity, Gas and Water Supply	-0.06	0.46	0.29	0.75	0.69
Construction	0.40	0.44	-0.41	0.03	0.43
Sales, Maintenance and Repair of Motor Vehicules and Motorcycles	0	0	0	0	0
Wholesale Trade and Commission Trade, Except of Motor Vehicules	-0.19	0.27	0.10	0.37	0.18
Retail Trade, Except of Motor Vehicules and Motorcycles ; Repair of HH goods	-0.19	0.27	0.10	0.37	0.18
Hotel and restaurant	0.28	0.35	0.11	0.46	0.18
Inland Transport	-0.33	0.35	-0.03	0.32	-0.01
Water Transport	-0.61	0.28	0.11	0.39	-0.23
Air Transport	-0.16	1.07	0.84	1.92	1.76
Other supporting and Auxiliary Transport Activities ; Activities of Travel Agencies	-0.71	0.90	0.03	0.93	0.22
Post and Telecommunications	0.74	0.69	-0.79	-0.11	0.63
Financial Intermediation	-0.37	0.30	0.05	0.35	-0.03
Real Estate Activities	0.01	0.40	-0.13	0.27	0.28
Renting of M& Eq and Other Business activities	-2.20	1.92	-0.95	0.95	-1.27
Public Administration and Defence ; Compulsory Social Security	-0.69	0.38	0.13	0.51	-0.18
Education	-0.33	0.87	0.14	1.01	0.68
Health and Social Work	-0.16	0.97	-0.64	0.32	0.16
Other Community, Social and Personal Services	0.08	0.62	-0.36	0.26	0.34
Private Househols with Employed Persons	0	0	0	0	0

Source: Author's calculations